

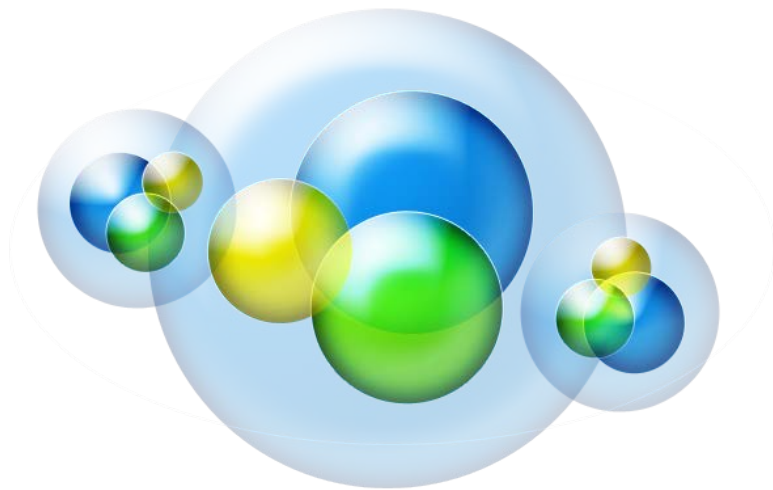
# Personal Exposure to Particles and Gaseous Pollutants



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Indoor Exposure Assessment Section  
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# Today's Presentation

- 🌐 Background
  - 🌐 Personal exposure, personal monitoring
  - 🌐 Physical properties and health effects of ultrafine particles (UFP)
- 🌐 Recent personal monitoring study (CARB)
- 🌐 Summary
  - 🌐 Lessons learned
  - 🌐 Future directions



# Background



# How is Exposure Defined?

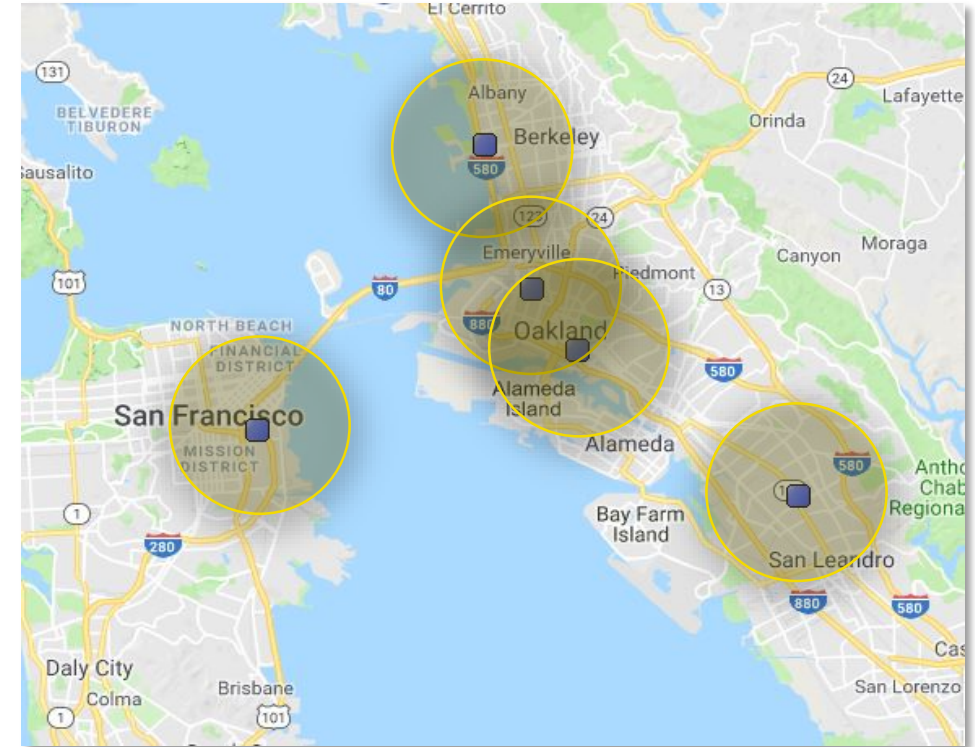
## Exposure not the same as concentration

- 🌐 Concentration – mass per unit volume
- 🌐 Exposure – **Concentration x time (duration of exposure)**
  - 🌐 “the contact of a chemical, physical, or biological agent with the outer boundary of an organism” (Berglund et al. 2002)
- 🌐 Dose – Exposure x dosimetry factor
  - 🌐 Amount of pollutant that enters body

# Ambient vs Personal Monitoring

## 🌐 Ambient monitoring

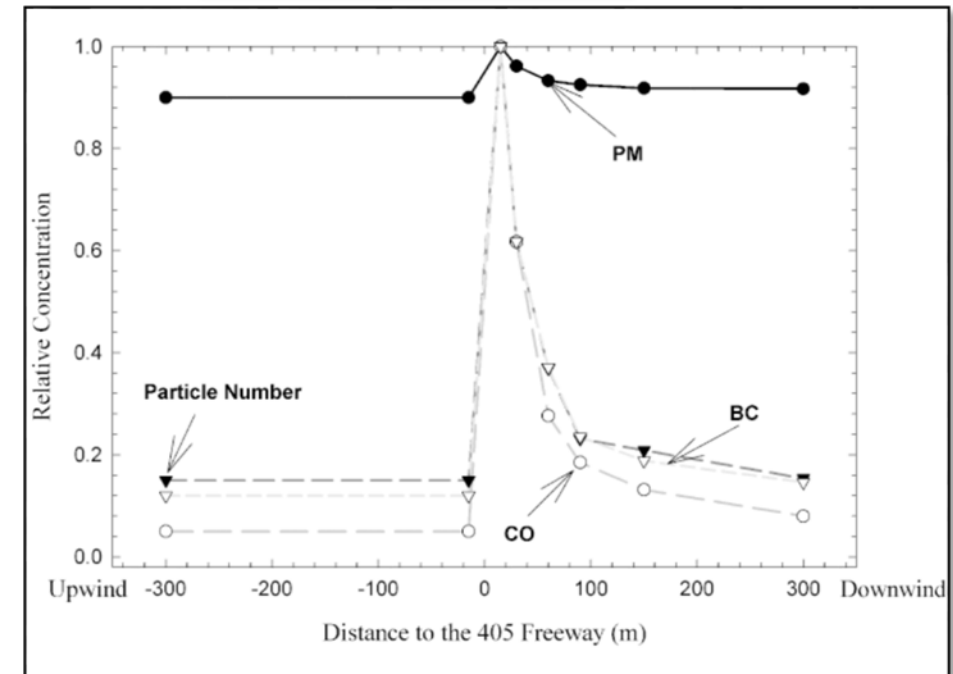
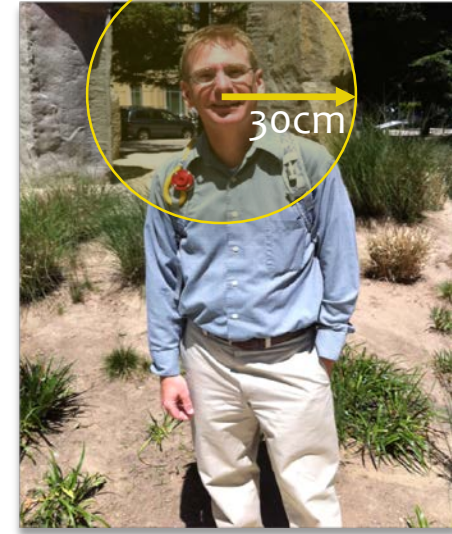
- 🌐 Does not accurately estimate personal exposure
- 🌐 Ambient monitors - not in “breathing zone” of subject
- 🌐 Incomplete time/activity
  - 🌐 Exposures do not stop at the entrance to home or work
- 🌐 Early studies (e.g. PTEAM) –  $PM_{10}$  exposures 1.5x higher than determined by ambient



# Ambient vs Personal Monitoring (con't)

## Personal monitoring

- Worn by participant
- Near real-time, short term exposure
- High spatial and temporal resolution
- UFP – Greater spatial and temporal variability than larger particles



Y. Zhu , WC. Hinds , S. Kim & C. Sioutas  
(2002) JA&WMA, 52:9, 1032-1042



# UFP – Physical Properties and Health Effects

UFP exposure and health effects not as well understood as larger particles

<0.10  $\mu\text{m}$  in size

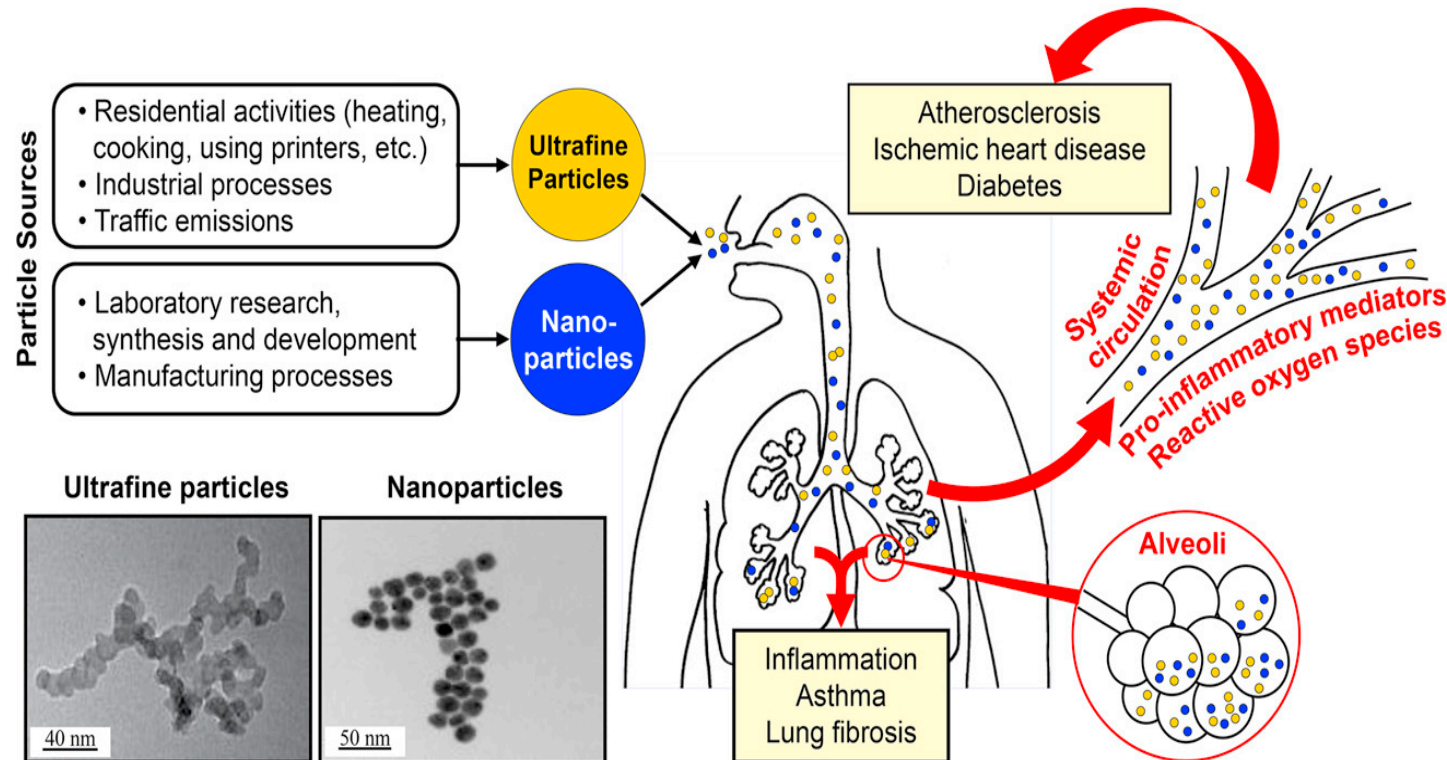
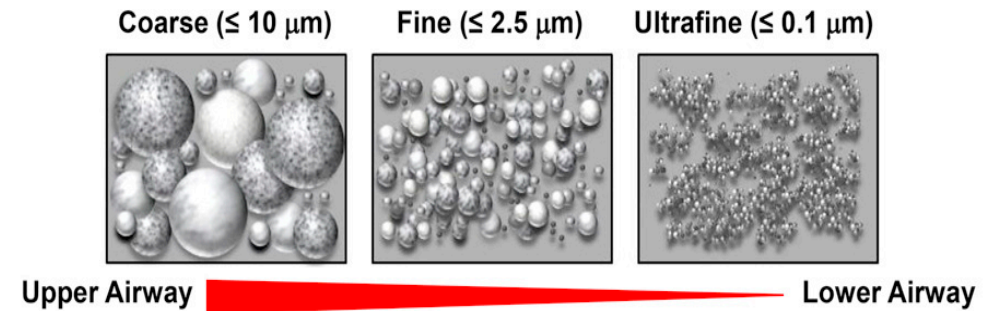
Human hair 50-70 $\mu\text{m}$

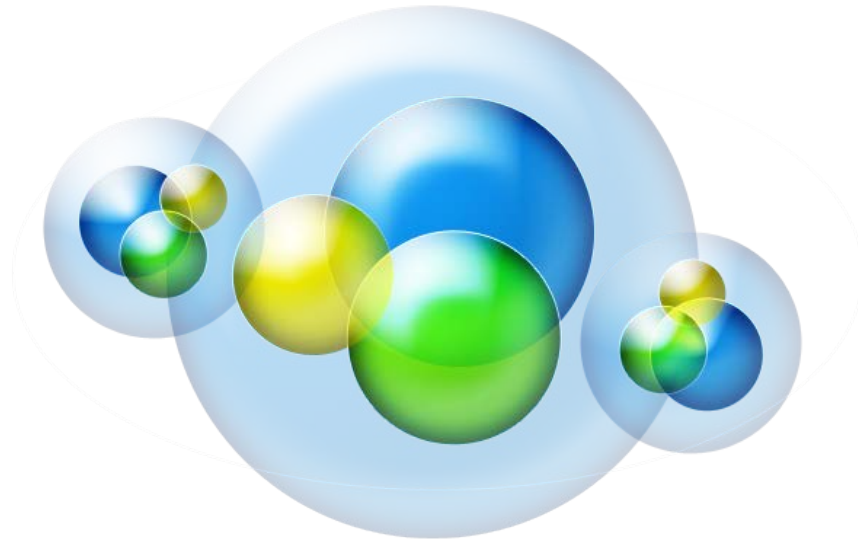
Negligible mass

Quantified by particle # conc or surface area

Proximity to source can greatly affect UFP exposure

N. Li, S. Georas, N. Alexis, P. Fritz, T. Xia, M.A. Williams, E. Horner, A. Nel, (2016) J Allergy Clin Immunol, 138:2, 386-396









# Pilot Study



# Personal Exposure Pilot Study

 Exposures to UFP, CO, NO<sub>2</sub>, PM<sub>2.5</sub>

## Study Aims

-  Determine pollutant concentrations for different microenvironments and activities
-  Estimate relative contributions of pollutants from indoor and outdoor microenvironments to personal exposure
-  Determine feasibility of larger exposure study in the future
  -  Evaluate sampling backpack and UFP monitor (usability for future studies)

# Study Design

- 15 participants (12 CARB staff and 3 children)
- Backpack with Instruments: DiSCmini (UFP), TSI AM520\* ( $PM_{2.5}$ ), CairClip ( $NO_2$ ), Langan T15n (CO), Qstarz GPS

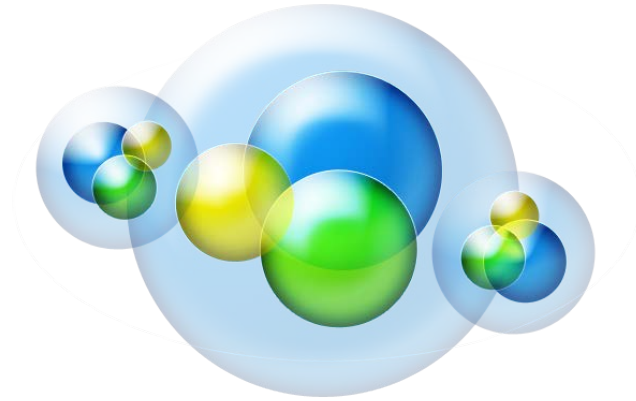


\*Only 3 participants



# Study Design (con't.)

- 🌐 Baseline survey
- 🌐 Daily activity diary/GPS
- 🌐 Backpacks carried for two 48h periods (later reduced to 24)
  - 🌐 One weekday and one weekend day (Sacramento area)
- 🌐 30 exposure profiles collected
  - 🌐 (626 hours of data - 87% completeness)
- 🌐 Exit survey
- 🌐 Six microenvironments defined (plus activities)
  1. Indoors at home (cooking, smoking, candle or incense burning)
  2. Outdoors Near Home (gardening)
  3. In Transit (driving, bus, train, biking, walking, etc.)
  4. At Work
  5. Outdoors Away Home
  6. Indoors Away from Home (restaurant, etc.)



# Key Results

# Concentration of UFP and PM<sub>2.5</sub> in Each Microenvironment

**Concentration by Microenvironment**      % Time    Mean      SD      5%    Med      95%

## UFP Concentrations (Part. #/cc)

Indoors at Home	59	10620	45538	575	3072	30489
Outdoors near Home	2	19107	17574	1415	13650	55278
In Transit	9	14674	60115	1247	7878	35105
At Work	16	5412	18277	582	2243	18147
Outdoors away from Home	3	11435	11640	526	9807	30902
Indoor away from Home	11	21489	58489	1045	4686	95191

## PM<sub>2.5</sub> Concentrations (μg/m<sup>3</sup>)\*    n=3

\* 24h NAAQS – 35μg/m<sup>3</sup>

Indoors at Home	60	15	15	7	11	24
Outdoors near Home	1.5	16	2	13	16	18
In Transit	10	23	26	4	18	40
At Work	21	5	8	2	4	9
Outdoors away from Home	2.5	21	3	17	21	24
Indoor away from Home	5	37	95	5	21	39

# Concentrations of CO in Each Microenvironment and NO<sub>2</sub> Indoors

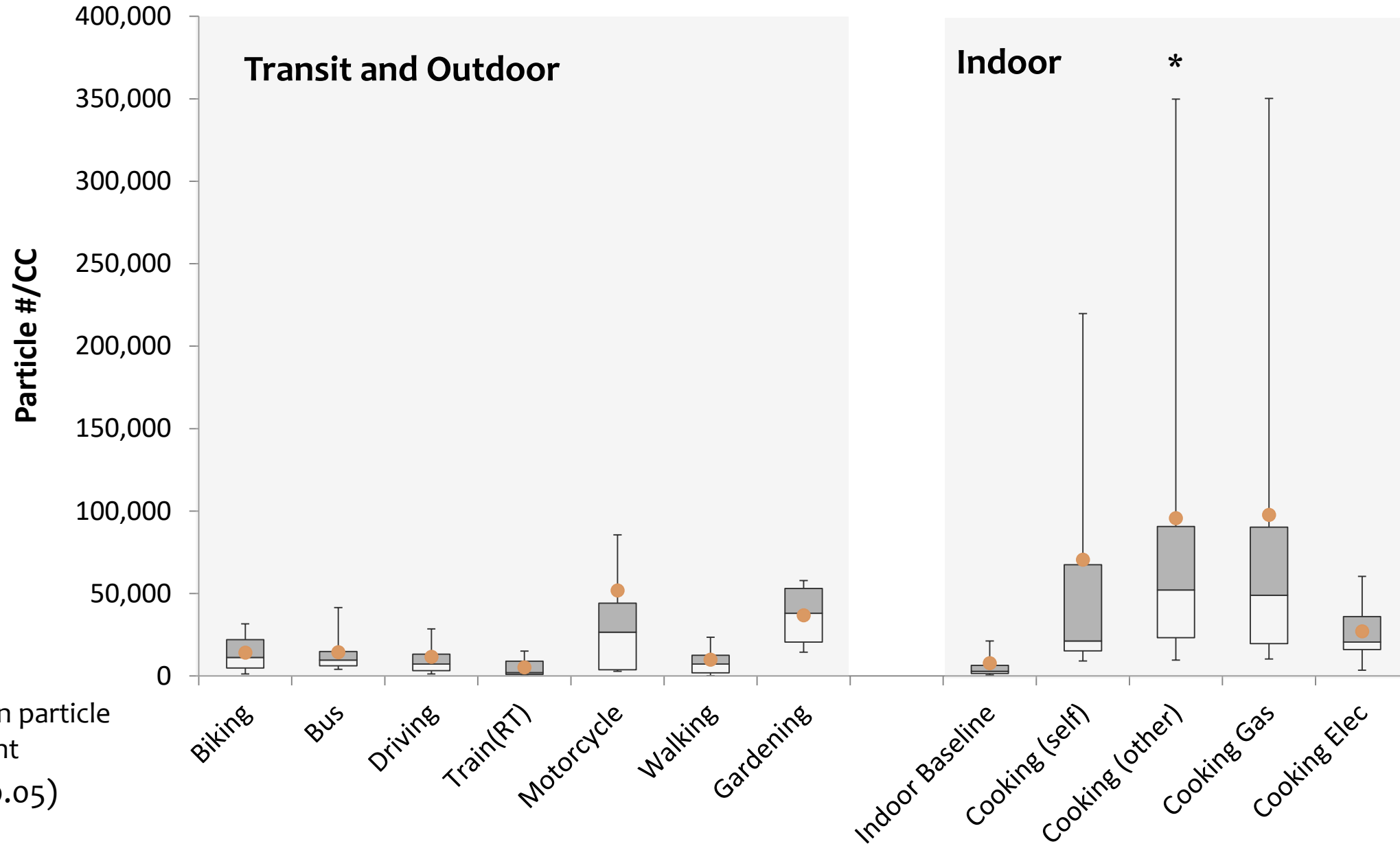
<b>Concentration by Microenvironment</b>	<b>% Time</b>	<b>Mean</b>	<b>SD</b>	<b>5%</b>	<b>Med</b>	<b>95%</b>
<b>CO Concentrations (ppm)*</b>						
Indoors at Home	59	0.48	0.68	0.03	0.23	1.53
Outdoors near Home	2	0.44	0.48	0.01	0.16	1.23
In Transit	9	0.69	1.11	0.04	0.43	2.08
At Work	16	0.36	0.51	0.01	0.18	0.98
Outdoors away from Home	3	0.48	0.71	0.00	0.24	1.88
Indoor away from Home	11	1.00	1.52	0.07	0.36	4.85
<b>NO<sub>2</sub> Concentration (ppb) indoor only**</b>						
Indoors at Home	59	5.1	7.5	1.0	4.0	14.0
Indoor away from Home	11	7.9	13.9	1.0	4.0	28.0

\*CA 8hr CO std – 9.0 ppm

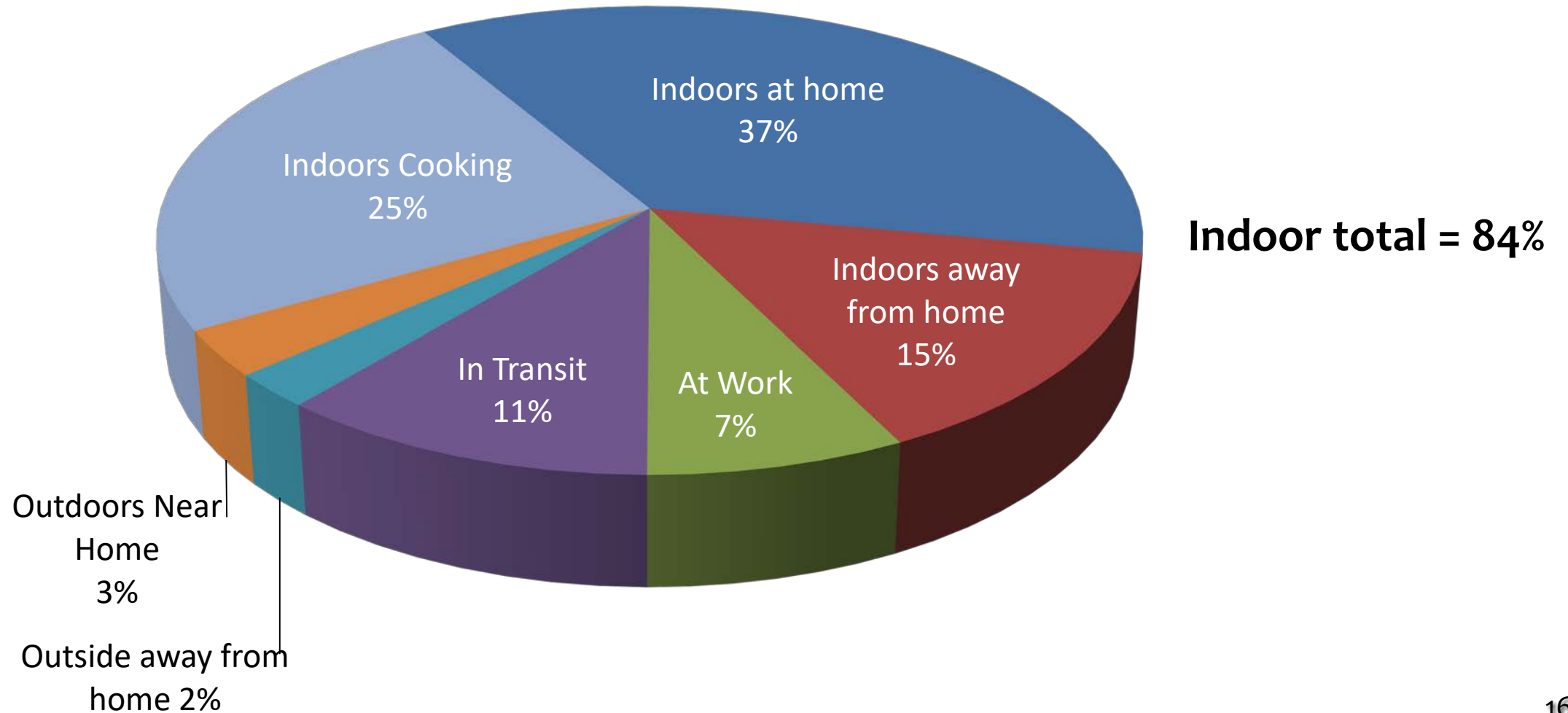
\*\*CAAQS Annual NO<sub>2</sub> – 30 ppb



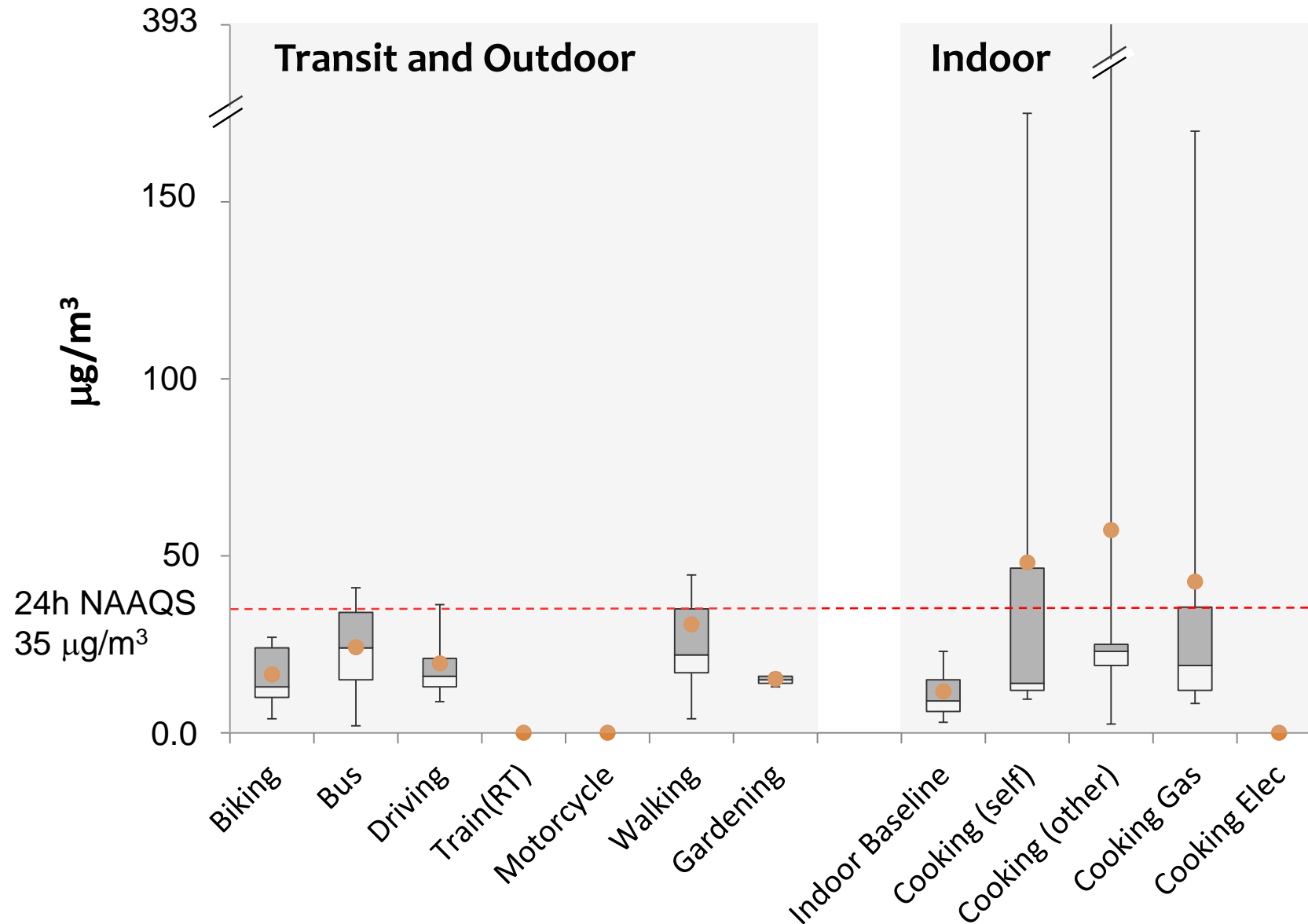
# UFP Concentrations by Activity



# Estimated Microenvironmental Contributions to Total UFP Exposure (24h)

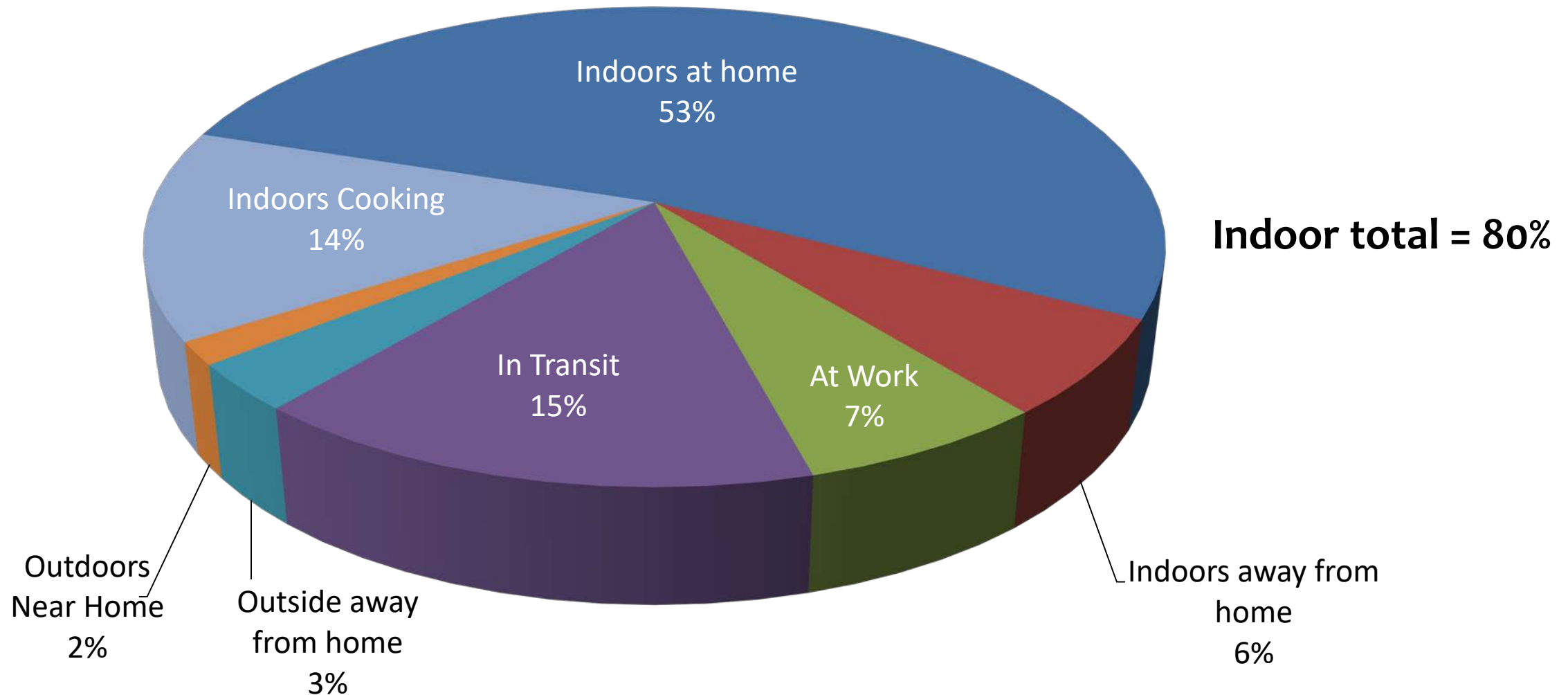


# PM<sub>2.5</sub> Concentrations by Activity \*

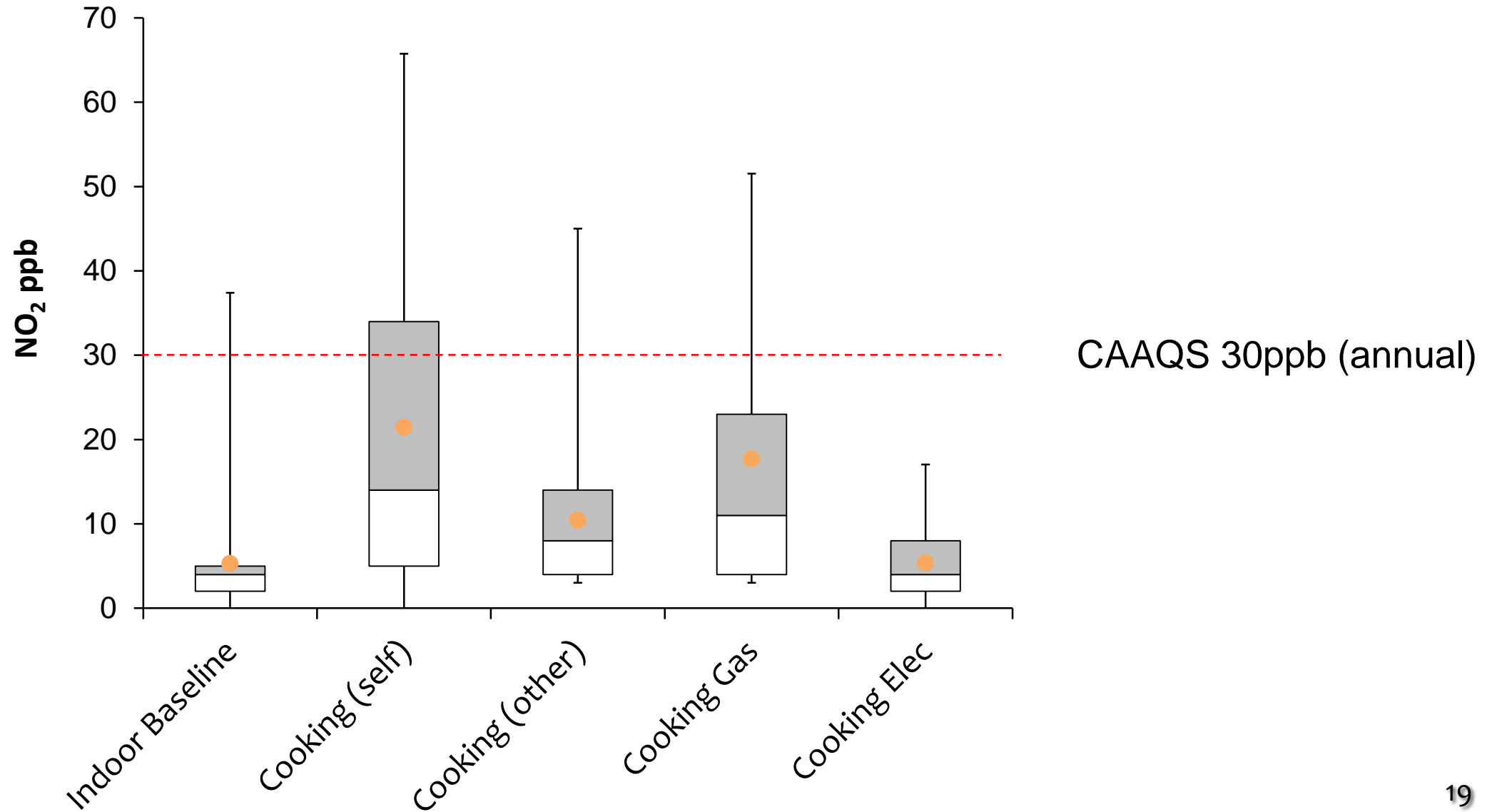


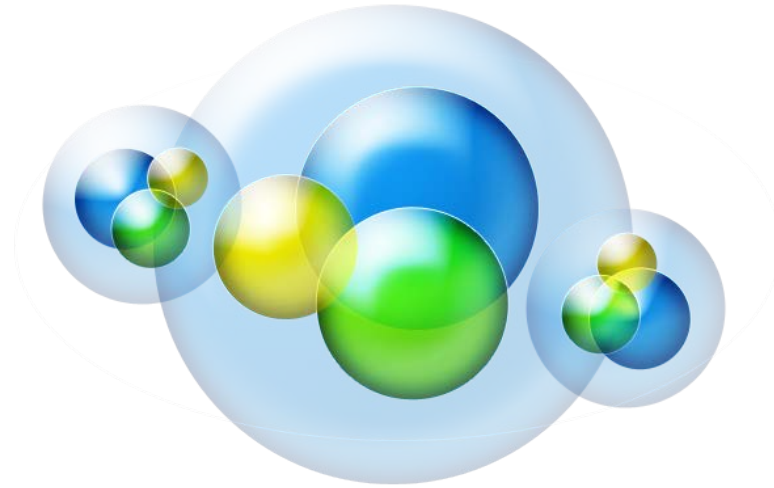
\* n=3 participants for total of 6 profiles (0 cooking w/electricity)

# Estimated Microenvironmental Contributions to Total PM<sub>2.5</sub> Exposure (24 h)



# NO<sub>2</sub> Concentration by Cooking Activity












# Summary



# Conclusions

## Pilot Study

-  > 80 percent of individual's UFP and  $PM_{2.5}$  exposure occurs within indoor microenvironments
-  Insight into peak concentrations
  -  Cooking and traffic sources
  -  Help minimize peak exposures
-  PM concentration and exposure in buses/vehicles/light rail relatively low
-  Indoor CO and  $NO_2$  exposures - elevated for cooking activity but generally low
-  Backpack and DiSCmini worked well for personal UFP measurements

# Limitations and Future Directions

## Limitations and lessons learned

-  Small sample size

  -  CARB staff not representative of California population

  -  One person in extreme environment can skew results

-  Longer data collection time and/or equipment responsibilities decreased compliance

-  Incorrect recall or incomplete activity diary

  -  GPS useful tool for confirming some activities

## Future directions

-  Personal exposures within EJ communities

-  Full scale personal exposure study

# Thank You

